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APOGEE® — A NEW PLANT BIOREGULATOR FOR APPLES

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INTRODUCTION

This Factsheet provides technical information on the use and benefits of prohexadione-calcium, a new growth-retardant compound for apples, produced commercially as Apogee®. This product was registered in Canada by BASF in the spring of 2005 (PCP #28042). Consult the product label for recommended use patterns and precautions, as well as the latest version of OMAFRA Publication 360, *Fruit Production Recommendations*, which may have more current information. The product label can be found online at the BASF Canada Inc. website (www.agsolutions.ca) or by searching the PMRA website (www.eddenet.pmra-arla.gc.ca/4.0/4.0.asp).

Research in both Canada and the U.S. and grower use in the U.S. since 2001 have confirmed that Apogee® can provide several benefits when applied to apple trees. Apogee® use reduces terminal shoot growth (ranging from 20%–60%), thus reducing the time required to dormant prune and/or summer prune and, in some instances, can negate the need to summer prune (see Figure 1, right). As a result, fruit colour can be improved on red-coloured cultivars. Trees treated with Apogee® often have the same number of shoots as untreated trees, but shoots from treated trees can be thicker (greater in diameter) and have compressed internodes. In addition, Apogee® use can reduce the incidence and severity of fire blight on shoots (shoot blight). A high number of Michigan growers have reportedly integrated Apogee® into their program, in part, because of the high risk of secondary fire blight in their region on the cultivars grown (i.e., Royal Gala). Furthermore, growers have cited improved spray coverage and reduced disease pressure as benefits of Apogee®, primarily attributed to reduced growth and the reduction in canopy volume and density.

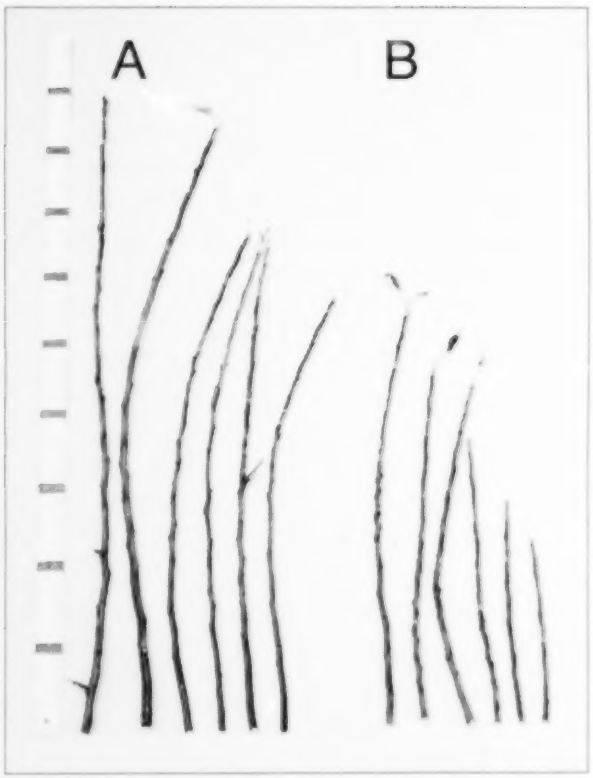

Figure 1. Six representative extension shoots taken from Royal Gala trees. Group A was untreated. Group B was treated with 3 sprays of Apogee® at 125 mg/L at 2-week intervals beginning at petal fall (right). (Metre stick marked at 10-cm intervals).

Recent evidence also indicates that trees sprayed with Apogee® develop phytoalexin-like properties. It appears that Apogee® induces changes in the spectrum and level of flavonoids within the plant, resulting in greater resistance to insects and disease.

CHEMISTRY AND MODE OF ACTION

Apogee® contains 27.5% (w/w) prohexadione calcium, a compound that is part of a new class of gibberellin biosynthesis inhibitors called the cyclohexanetriones. Prohexidione-calcium is known to reduce terminal growth by inhibiting 2-oxoglutarate-dependent dioxygenases, which are involved in the formation of growth-specific gibberellins (e.g., the conversion of GA_{20} to GA_1), a group of plant hormones that are primarily responsible for regulation of shoot elongation in apple trees. In addition, it is also known that prohexadione-calcium interferes with ethylene biosynthesis and flavonoid metabolism, which can influence other responses in the plant. No negative effect on the number of leaves per shoot has been observed, although preliminary reports from the northeastern U.S. suggest that the prohexadione-calcium can directly reduce fruit growth when used at higher concentrations (e.g., above 125 ppm). Once applied, Apogee® requires about 14 days to slow growth. It degrades in the tree within a few weeks, so at least one repeat application may be necessary to maintain growth control throughout the entire growing season.

Patterns of terminal growth and fruit set characteristics differ among growing regions. Likewise, the response to Apogee® appears to differ depending upon where it is used. Therefore, a regional interpretation of the label is likely necessary to obtain maximum response from this product.

TIME OF APPLICATION, RATES AND COST

Terminal shoot growth in Ontario proceeds rapidly, usually during the first six weeks of the season. Since 2 weeks are required for Apogee® to slow growth effectively, be sure to make the first application when terminal shoots are no longer than 2.5–5 cm. This typically coincides with late bloom or petal fall, when the bourse shoots are beginning to grow and when sufficient leaf area has developed for prohexadione-calcium to be translocated into the leaves — primarily spur leaves early in development. Satisfactory results from the use of Apogee® depend upon making the first application at this time, and no later. It reportedly is not toxic to bees, so the first application can be made before bees are removed from the orchard.

The factors that determine Apogee® application rate are primarily tree size, vigour (influenced by rootstock, cultivar, soil, crop load and site) and whether protection against shoot blight is an objective. The label recommends 45 g of product per 100 L of dilute spray (125 ppm) for medium- to high-vigour trees, and 75 ppm for low- to medium-vigour trees. Make repeat applications at 14–21-day intervals. Based on t 125 ppm rate and a tree row volume dilute rate 1,000 L/ha, 900 g of product/ha (364 g/acre) will required. The 2006 suggested grower price for Apoge in Canada is $251/kg. Therefore, the cost of Apogee® two applications at the "standard" rate for 1,000 L/ (TRV dilute) trees will be $226/ha or $91/acre.

Follow the steps on the product label to adjust rates f tree-row volume dilute applications. Table 1, on page shows various rates for sprays applied at 1,000 L/ (dilute). Apogee® has been used effectively when appli in water volumes less than TRV, provided the canopy h been thoroughly wetted. However, concentrate sprayi of plant growth regulators and chemical thinners is n generally recommended.

ORCHARD SYSTEMS

Apogee® is an effective tool for regulating vegetati growth for a number of different orchard systen planting densities and rootstocks. It has application f larger, widely spaced trees on semi-vigorous rootstock Since growth control can be more challenging on th type of orchard system, more frequent and high concentrations may be required. In contrast, on young super spindle orchards where annual net growth desired until the trees have filled their allotted spac Apogee® may be targeted specifically to the lower part the canopy and perhaps at lower rates to reduce t amount of upright vegetative growth.

ADJUVANTS AND HARD WATER

A spray adjuvant (Agral 90, LI-700) should be includ to improve uptake of the prohexadione-calcium molecu by the leaf. In addition, where a high calcium magnesium water source (hard water) is used, it important to include an equal amount of ammoniu sulphate (AMS) fertilizer by weight with Apogee®. AM acts by lowering the pH of the spray solution and al aids in the translocation of the active ingredient acro the leaf cuticle and cuticular membrane. Use a hig quality, greenhouse grade of AMS to avoid pluggi nozzles. This is readily available from suppliers such Vineland Growers and Plant Products for around $2 per 25-kg bag, representing inexpensive "insurance" ensure product efficacy. If you are on a municipal wat system, determine the hardness level of your water fro your supplier. If you have a private water supply, ha your water tested for hardness (for a fee). Consu www.ene.gov.on.ca/envision/water/sdwa/licensedlabs.htm for a list of accredited labs. The last column in the tab lists which labs are accredited for inorganic analysis.

Table 1. Suggested Apogee® rates and timings based on a tree-row volume dilute of of 1,000 L/ha
(Use this chart in conjunction with the product label.)

Level	Tree vigour[1]	1st Spray (May 25[2]) Petal fall	2nd Spray (June 8[2]) Fruit set	3rd Spray (June 22[2]) June drop	4th Spray (July 6[2])	Season total (g/ha)[3]	Product cost per season (2006) /ha[4]	Product cost per season (2006) /ac[4]
		grams Apogee®/ha based on 1,000 L/ha TRV Dilute[5]						
1	Low: 1 spray	450				450	$ 113	$ 46
2	Low: 2 sprays	270	270	–	–	540	$ 136	$ 55
3	Medium: 2 sprays[6]	450	450	–	–	900	$ 226	$ 91
4	Medium/High: 3 sprays	450	450	270	–	1,170	$ 294	$ 119
5	High: 3 sprays	450	450	450	–	1,350	$ 339	$ 137
6	High: 4 sprays	450	450	450	270	1,620	$ 407	$ 165

Orchard and Environmental Factors to Adjust Apogee® Rates and Number of Sprays

Heavy dormant pruning	Increase rate by 10%–20% per hectare per spray.
Longer growing season	Add 3rd or 4th spray.
Low crop load	Move Apogee® Program to next higher level (i.e., tree size).
Questionable coverage	Move Apogee® Program to next higher level (i.e., tree size).
Fire blight supression	Move Apogee® Program to next higher level (i.e., tree size) or apply (65 g/100 L) initial rate.
Cultivars	
Very sensitive to Apogee®	Consider reducing or dropping 3rd and 4th sprays.
Sensitive to Apogee®	Use rates above.
Less sensitive to Apogee®	Consider increasing rate by 10% per hectare per spray.
Special	For spur types, use rates for low-vigour trees and reduce rates by 20% rate.

1 Vigour is defined as the total amount of shoot growth in a single season. Not to be confused with tree-row volume.
2 Typical date. The first application will depend on growth development in your area and by cultivar. Apple trees in Niagara and southwestern Ontario are often 7–10 days ahead in development compared with trees in Georgian Bay and eastern Ontario.
3 Maximum seasonal rate should not exceed a total of 5.4 kg of Apogee®.
4 Prices may vary by supplier. Calculation based on manufacturer suggest retail price of $251/kg and tree row volume of 1,000 L/ha.
5 Tree row volume (for more details, see www.omafra.gov.on.ca/english/crops/ and click on "Apples." Under "Apples: Pest management," click on *Guide for Spraying Fruit Trees*.). Increase rates when higher water volumes are required for adequate spray coverage.
6 Suggested base rate. Move to next higher or lower level, based on orchard and environmental factors listed above.

TANK MIXING

The Apogee® label recommends that calcium sprays should not be tank-mixed with Apogee®. This warning is especially appropriate for calcium chloride and other calcium-containing products. In the presence of calcium, Apogee® will precipitate in the tank, clog nozzles and screens, and reduce tree response.

INCREASED FRUIT SET

In some instances, Apogee® may increase fruit set and make thinning more difficult. This response is not consistent but is more likely at concentrations above 125 ppm (45 g/100 L). Apogee®-treated trees may require more aggressive chemical or hand thinning to reduce the crop load to the desired level.

OTHER PRECAUTIONS

There are published reports in the U.S. that Apogee® can cause severe cracking on Empire and Stayman cultivars. The cause is unclear, and cracking has not been observed in research blocks at the University of Guelph, Simcoe, after treatment of Empire trees for several years. Producers who wish to use Apogee® on Empire should be aware of this precaution, and perhaps use it on a limited acreage of their Empire trees for a few years to determine the real risk of cracking in our region. The label also cautions growers that Apogee® may result in a decrease in yield and marketable yield of Cortland. Despite this, clear benefits of using Apogee® on tip-bearing cultivars such as Cortland and Northern Spy have been observed in other regions of Canada, where the shortened internodes of Apogee®-treated trees have produced a more compact tree habit.

SUGGESTED STRATEGY FOR USING APOGEE®

- Consider using Apogee® on your most fire blight–sensitive, high-value and vigorous-growing cultivars first.
- Compare your present summer and dormant pruning costs with the cost of using Apogee® (widely available at major Ag-chemical suppliers). Count on about 40% reduction in vegetative growth. Don't forget to include the other benefits of Apogee® when making this comparison.
- Consider using Apogee® on terminal-bearing cultivars such as Cortland, Golden Russet and Northern Spy. It has been shown in Nova Scotia to dramatically improve the tree habit of Cortland.
- Apply the first application early — no later than petal fall. Don't forget to add a surfactant and AMS

if you have or suspect hard water. A second spray 14–21 days later is almost always required.

- If unsure about what rates to use, start with the standard rate of 45 g Apogee® per 100 L spray solution and apply tree-row volume dilute.
- Direct spray and adjust nozzles to apply more spray to the tops of trees.
- On young trees, consider applying to the top of the canopy only. This may provide added fire blight protection for sensitive cultivars (i.e., Royal Gala), while maximizing growth potential.
- Be sure to leave several unsprayed trees for comparison purposes (and flag them).
- Consider measuring the length of approximately 100 randomly selected extension shoots per cultivar (from treated and untreated trees) on a 7- or 10-day basis until terminal bud set. This will reveal when trees start and stop growing.

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